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ABSTRACT

Designed to aid in the identification of reasons why qualified women do not pursue careers in mathematics, this study surveyed nine schools. Fourth, ninth, and twelfth grade students were selected from inner city and suburban schools. Six schools were selected for the fourth grade, and three schools were selected at the ninth and twelfth grade levels. Four girls, four teachers, and two guidance counselors at each grade level were randomly selected for interviews from the participating schools. Instruments were developed to measure confidence in doing mathematics, to measure interest in mathematics, to determine future plans to study mathematics and reasons for the decisions, and to determine career plans and reasons for the choices. The only statistically significant result from the questionnaires appeared on the question of interest at the twelfth grade level. Girls scored significantly lower than boys at the .01 level of significance. Interview question responses indicated that there is a decrease in girls' interest in mathematics and a sharp increase in societal pressure against women in mathematics during the students' high school years. (Questionnaires and interview questions which were developed for each grade level are appended.) (LRA)

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IDENTIFICATION OF REASONS WHY QUALIFIED WOMEN DO NOT PURSUE MATHEMATICAL CAREERS

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1. Introduction

a. Background of the Problem

The present study was designed to aid in the identification of reasons why qualified women do not pursue careers in mathematics.

Unlike areas of endeavor in which different physical or emotional characteristics may account for a lack of or overabundance of women, mathematics seems to involve no inherent differences between men and women. Hence, the reasons why relatively few women have chosen careers in mathematics are apparently due entirely to the differing roles which society assigns to men and women. The present study attempts to contribute toward our knowledge of societal patterns by providing data to answer the following questions:

1. Do girls avoid mathematical studies throughout their lives? Do girls avoid mathematics at a continuously increasing rate as they mature? Are there sudden changes, at particular ages, from interest to disinterest in mathematics?
2. What factors discourage girls from studying mathematics? To what extent do educators impose barriers against women or attempt to remove barriers imposed by other segments of society?
3. What factors discourage girls from choosing careers involving mathematics? What role do educators play in shaping these decisions?

b. Conjectures

The study is confined to mathematics because it is believed that there may be differences in attitudes toward women among the various

sciences. In the laboratory sciences, it may be the prevailing opinion that women are not as capable as men in working with heavy or complex laboratory equipment. The tools of mathematics, on the other hand, involve only pencil and paper or computers. It is also believed that the ages at which girls are discouraged from careers in the various sciences may differ. High school graduation requirements may contribute to these differences.

The results of the study identifies the age level at which girls are discouraged from mathematical studies and the major sources of the barriers confronting them. It has been conjectured that there is a sharp increase in societal pressure against women in mathematics during the student's high school and college years and that mathematics teachers and guidance counselors contribute toward building barriers against women rather than removing society's barriers. An examination of the results of the study can aid in designing programs to encourage qualified girls to pursue careers in mathematics.

c. Hypotheses

The following specific hypotheses were tested:

1. Mathematical confidence is independent of sex, at the fourth grade level.
2. Mathematical interest is independent of sex, at the fourth grade level.
3. Mathematical confidence is independent of sex, at the ninth grade level.
4. Mathematical interest is independent of sex, at the ninth grade level.
5. Mathematical confidence is independent of sex, at the twelfth grade level.

6. Mathematical interest is independent of sex, at the twelfth grade level.
7. Mathematical confidence is independent of sex, at the college sophomore level.
8. Mathematical interest is independent of sex, at the college sophomore level.

Eight instruments were developed to test these hypotheses; the chi-square statistic was used to test independence.

Open-ended questionnaires and interviews were used to derive information concerning the role of educators in imposing or removing barriers against women in mathematics. The hypotheses, which were of interest, were the following:

1. In fourth grade mathematics classes, there is no difference in the treatment of boys and girls.
2. In ninth grade mathematics classes, there is no difference in the treatment of boys and girls.
3. In twelfth grade mathematics classes, there is no difference in the treatment of boys and girls.
4. In college freshman and sophomore mathematics classes, there is no difference in the treatment of men and women.
5. Academic counselors and advisors, at each of the four grade levels, give the same educational and career advice to boys and to girls.

d. Significance of the Problem

An examination of the results of the study can aid in designing programs to encourage qualified girls to pursue careers in mathematics. Special attention should be given to implementing such programs at the

age level at which the greatest drop-out of mathematically gifted girls occurs. Attention should also be given to designing in-service education programs for teachers and guidance counselors at the levels at which they exert a negative influence toward girls as mathematicians.

e. Methods and Procedures to be Followed

The following outline describes the experimental procedures which were planned to study reasons why qualified women do not pursue mathematical careers.

1. Develop instruments and questionnaires to measure confidence in doing mathematics; to measure interest in mathematics, and to analyze discriminatory and preferential treatment of women in mathematics.
2. Establish the validity and reliability of the instruments designed to measure confidence in doing mathematics and to measure interest in mathematics.
3. In accordance with the results of the validity study, write the revised version of the instruments for measuring confidence in doing mathematics and for measuring interest in mathematics.
4. Determine the methods to be used for analyzing the data to be collected. Consider the questions of whether mathematical confidence and mathematical interest are independent of sex, at the four age levels to be studied.
5. Administer the various instruments and questionnaires.
6. Interview students, teachers, guidance counselors, and mathematicians.
7. Analyze the data.

8. Summarize the subjective comments.

9. Draw conclusions.

10. Suggest methods, based on the results of the study, which can be used to attract a greater number of qualified women to mathematical careers.

11. Consider questions for further study which were suggested by the experiences and outcomes of this study.

12. Disseminate the results of the study and submit a final report to the National Science Foundation.

2. Related Studies

There is a vast quantity of literature which is peripherally related to the problem. Some previous studies, for example, indicate that there are no significant differences between elementary school boys' and girls' aptitudes for estimating quantities, (12) identifying geometric figures, (53) and demonstrating creativity in the solutions of mathematical problems. (22)

Many studies have been concerned with counting women scientists, (16) comparing the salaries of men and women in science, (54) and reporting anecdotal responses of women scientists who have attempted to analyze their success in overcoming society's barriers. (58) One study concluded that women in scientific careers had parents who held learning in high regard and had teachers, as early as the second grade, who encouraged their interest in science. (11)

Much attention has also been given to the success of various programs in continuing education and to the particular problems faced by undergraduate women in contrast to those faced by undergraduate men. (57)

It has been conjectured that this is the stage of life when women are most likely to experience a conflict between scientific interests and the challenge to their femininity which they fear is represented by such interests. (10)

Other studies, which are somewhat related to the present problem, have emphasized that women Ph.D.'s are denied the "informal signs of belonging and recognition" and are especially denied the opportunity to work with other professionals. (52) Furthermore, it has been claimed that "striving for a career in predominantly masculine professions is not as rewarding for a woman, psychologically or socially, as for a man because such a women is singled out as an oddity in our culture." (27) In a project designed to determine discrimination in the hiring of women faculty members in departments of physical science, it was concluded that the greatest discrimination occurs in "higher quality" schools, in departments chaired by young faculty members or recently appointed department heads, and in colleges and universities in the East and West; there is less discrimination in the Midwest and South. (30)

Various studies have been devoted to career interests and attitudes of adolescents. Among the conclusions are that career commitment of girls decreases significantly from junior high school to senior high school years; (31) junior high girls are more modest in their estimate of their academic ability than boys; (55) black girls have higher aspirations than black boys; (43) and boys seek power, profit, and recognition, (42) while girls seek self-expression and social service. (47)

At the Invitational Conference of the Educational Testing Service in the autumn of 1972, Eleanor Maccoby listed a summary of findings,

up to that time, of cognitive differences between boys and girls. She concluded that girls tend to be superior on verbal abilities and boys tend to be superior on spatial and mathematical aptitudes, that spatial relations is the most consistent and strongly differentiating aptitude between the sexes, and that differences in aptitudes do not become significantly apparent until adolescence. (17)

L. R. Aiken, in 1970, reported that a number of investigators adhere to the theory that the cognitive differences between the sexes are the result of differential cultural reinforcement over time, since the differential increases with age. (17)

Additional recent studies have drawn conclusions consistent with those of earlier research efforts. In analyzing sex differences in mathematical and scientific precocity, Astin found that boys show interest and precocity in mathematics at a much earlier age than girls, the discrepancies in mathematical aptitude scores between boys and girls increase with age, and girls' parents have low expectations for their daughters. (3) And, John Ernest and his research team corroborated the evidence that there is nothing intrinsic in mathematics that makes it more appealing to one sex than the other but teachers expect male students to do better in mathematics than female students. (13)

According to the report of the Carnegie Commission on Higher Education the percentage of women Ph.D.'s in mathematics has been steadily decreasing, with only a slight upswing in recent years. In the period 1920-24, 20% of the mathematics Ph.D.'s were earned by women. During the past year the percent of women on faculties of college mathematics departments has increased from 5.6 to 5.8, while the percent of tenured women faculty members has decreased from 4.6 to 4.5. During this period of time the percent of women among new Ph.D.'s has increased from 9.1

to 10.1 while the percent of women among unemployed new Ph.D's has increased from 11.1 to 15.0. (8)

In a study related to the Project Director's dissertation, the following question was investigated: Do male secondary school mathematics teachers exhibit a greater degree of mathematical confidence than female secondary school mathematics teachers? The pretest confidence scores of 37 men and 44 women in the 1969-70 N.S.F. In-Service Institute at the University of Cincinnati were compared. The difference between the two means was found to be significant at the .05 level, indicating that men teachers felt more mathematically confident than women teachers. The 53 posttest scores were analyzed, and again, the difference between mean scores of men and women was significant at the .05 level. There was no attempt, however, to analyze whether the statistically significant difference between confidence scores of men and women was due to a difference in environmental reinforcement of boys' confidence in solving mathematics problems. (29).

3. Design of the Study

a. Sampling

Participants for the final phase of the study were selected from the Greater Cincinnati area. Fourth, ninth, and twelfth grade students were selected from inner city and suburban schools. Six schools were selected at random at the fourth grade level; three schools were selected at random at the ninth and twelfth grade levels; and an equal number of students was selected, randomly, from each school. The population for the study was restricted to "qualified" mathematics students, where 'qualified' was defined to be ranked in at least the 75^{th} percentile on a standardized test taken within the past year. College sophomores at the University of Cincinnati, whose SAT or ACT mathematics scores

placed them in at least the 75th percentile, were randomly selected to participate in the study.

Four girls, four teachers, and two guidance counselors at each grade level were randomly selected for interviews from the participating schools.

In January, 1975, at the Annual American Mathematical Society-Mathematical Association of America Meeting, in Washington, D.C., fourteen women mathematicians were interviewed. Twenty-two women were contacted; they had been recommended as probable subjects by Professor Mary Gray, the founder of the Association for Women in Mathematics. Twenty-one expressed their willingness to cooperate, but only 14 were able to attend the Annual Meeting. These 14 women represented a variety of ages--from the late 20's to the late 60's--a variety of backgrounds, race, life-styles, and personalities. But, they had two things in common: they had succeeded in becoming mathematicians and they had experienced similar forms of both encouragement and discrimination along the way.

b. Instrumentation

Four instruments were developed at each level:

1. An instrument to measure confidence in doing mathematics.
2. An instrument to measure interest in mathematics.
3. A questionnaire to determine future plans to study mathematics and reasons for the decisions.
4. A questionnaire to determine career plans and reasons for the choices.

The first two instruments were developed in a two-stage pilot project. The first stage involved interviewing six students at each level, and then writing a set of items relating to mathematical confidence and

mathematical interest which required open-ended responses. At the fourth, ninth, and twelfth grade levels, volunteers for both stages were selected from the Cincinnati Public Schools. College sophomores were chosen from volunteers at the University of Cincinnati. Each student, in the first stage of the project, was interviewed for approximately half an hour.

Among the interesting, enlightening, and sometimes entertaining responses were the following:

"Confidence more than interest influences one's choice of a career."

"Girls aren't as talented in mathematics as boys. They're conscientious but not talented. They have no 'spark.'"

"Top grades in mathematics imply intelligence. Top grades in English literature do not imply intelligence. My parents worry about whether a husband out there somewhere won't like me if I'm intelligent."

"College instructors of mathematics regard girls with humor. If they're there, the instructors will try to get them to pass the course. If they're bright, the instructors are surprised."

"College instructors of mathematics or physics regard girls with amused tolerance."

"Girls tend to give up more easily if they cannot work the problems. But, the top girls in a class set the standard for the entire group. The better girls stick out more than the better boys."

"I went to a coeducational parochial elementary school. I remember an incident that happened when I was in the fifth grade. A

boy in the class was caught cheating on a test. He was copying from the paper of the girl sitting next to him. In reprimanding him the nun said, 'Imagine you copying from a girl's paper.'"

Twenty volunteers, at each grade level, responded to the questionnaires in the second stage of the pilot project. At the three lower levels, teachers allowed about twenty minutes during class for the completion of the questionnaire. At the college sophomore level, the second stage of the project was carried out by mail. From these responses, the eight instruments were devised. Each contained approximately 35 items and required the student to respond to a five-point Likert scale. Pilot groups were then selected and, on the basis of their responses, the most discriminating items on each instrument were selected. Pilot groups consisting of approximately 125 students at each level, were again selected from volunteers in the Cincinnati Public Schools, at Mt. Holyoke College, and at the University of Cincinnati. In all cases, students responded to the questionnaires during class time.

Previous experience indicates that attempts to establish the validity of such instruments on the basis of concurrent criteria usually fail since it is impossible to obtain a set of representative, unbiased criterion scores. Hence, the instruments themselves define mathematical confidence and interest in mathematics. The items were reviewed by a selected group of mathematicians, mathematics educators, and psychologists at the University of Cincinnati. Their combined judgment provides the basis for establishing the validity of the instruments.

The split-half technique, employing the Spearmen-Brown Prophecy Formula was used to establish the reliability of the instruments. Reliability coefficients varied from .687 to .919. The reliability coefficient for each test is given in Table I.

Table I.

Questionnaires--Reliability Coefficients

	4th grade Confidence	4th grade Interest	9th grade Confidence	9th grade Interest	12th grade Confidence	12th grade Interest
n	121	121	64	64	80	82
R	.687	.803	.857	.905	.905	.906

	College Sohpomore Confidence	College Sophomore Interest
n	173	173
r	.870	.919

Appendices B, C, and D contain copies of the instruments used in the pilot projects and in the final study as well as an explanation of their use.

Mathematical confidence was defined as a score in the top 25% on one of the confidence instruments. Interest in mathematics was defined as a score in the top 25% on one of the interest instruments.

The questionnaires to determine future plans to study mathematics and to pursue mathematical careers were developed with the assistance of the educators and psychologist who were consultants in the project. The questions required brief, open-ended responses.

In addition to the written instruments, hour-long interviews were conducted with a random sample of 4 girls at each level to allow freedom of response and to probe deeper into the various issues involved.

Similar questions to those used in these interviews were presented to a sample of women mathematicians in order to compare their retrospective responses with the responses of the present students.

Further information was provided by interviewing a random sample of four mathematics teachers and a guidance counselor or academic

advisor at each grade level. With the assistance of the consultants a set of questions was formulated to elicit both quantitative responses and explanations for the answers given. An analysis was made of the quantitative responses and anecdotal records of the interviews were summarized. There was an attempt to analyze teachers' treatment of their students, their attitude toward women in mathematics, the extent to which educators discourage women's participation in mathematics, and the extent to which attitudes differ among educators of various grade levels.

c. Administration of Instruments

Fourth, ninth, and twelfth grade students responded to the instruments during regular school hours.

Arrangements were made well in advance of the testing period with superintendents, principals, guidance counselors, and teachers. The experiences which we had in our attempts to secure the cooperation of various school systems were probably typical of the experiences of investigators in similar studies. We found it easier to work with small school systems than with large ones. Generally, the fears of school administrators and the accompanying red tape were in inverse proportion to the age of the students whom we wished to survey. In three schools, principals required written permission from fourth grade parents; copies of all questionnaires and interview questions were supplied to the parents along with a letter explaining that the project was designed to study differences between the sexes in their attitudes toward mathematics. One junior high school principal and one senior high school principal required similar letters to be sent to the parents of their participating students. Generally, in spite of some instances of initial hesitation and some red tape, we found principals, teachers, counselors, and students overwhelmingly cooperative.

Teachers selected students to be interviewed and notified them several days before the interviews. In a like manner, principals or supervisors selected teachers and guidance counselors to be interviewed. In all cases, participation was voluntary, but everyone who was selected agreed to take part.

Classrooms, normally empty at the given time, or auditoriums were used to administer the written questionnaires. Interviews were held in offices or classrooms which were not in use for other purposes.

Written questionnaires were mailed to all sophomores in the College of Arts and Sciences at the University of Cincinnati whose ACT or SAT scores were in the seventy-five percentile or above. Self-addressed, stamped envelopes and explanatory letters were included. The women also received forms for volunteering to participate in an interview. Two hundred seventy-nine questionnaires were mailed; one hundred seventy-three were completed and returned. Four women were randomly selected among the volunteers to be interviewed and arrangements for convenient times were made by telephone. The principal investigators for the study conducted the interviews in their offices. Four faculty members were randomly selected for interviews from the Department of Mathematical Sciences at the University of Cincinnati.

Women mathematicians were interviewed at the Annual American Mathematical Society-Mathematical Association of America Meeting in Washington, D.C., in January, 1975. Arrangements for these interviews were begun in the summer of 1974 and were completed several weeks before the interviews took place.

Although all the participants seemed to enjoy the interviews, the older students and the adults demonstrated the greatest interest. It was the college sophomores and women mathematicians who were the most

enthusiastic about our study and the most eager to prolong the interviews. As a matter of fact, one interview with a female mathematician, planned for half an hour, lasted two and a half hours. Our conversation ranged from childhood memories of mathematics classes to collective bargaining in higher education and the solution, at the bargaining table, of some of the problems involving inequities between men and women. All in all, we found that people like to talk about themselves, and they like to discuss issues which have profoundly affected their lives.

4. Analyses of the Data

a. Statistical Analysis

As in many educational experiments, we found almost no statistically significant differences. Using the criterion that confidence is defined as scoring in the top 25% on the confidence instrument and interest is defined as scoring in the top 25% on the interest instrument, the Chi-square statistic was used at each level to determine whether mathematical confidence is independent of sex and whether mathematical interest is independent of sex. The only statistically significant result appeared on the question of interest at the twelfth grade level. Girls scored significantly lower than boys at the .01 level of significance. At both the ninth grade and college sophomore levels, the proportion of girls interested in mathematics was, in fact, higher than the proportion of boys, but not sufficiently higher to reflect statistical significance. At the fourth grade level, a greater proportion of girls than boys was mathematically confident; while, at the ninth and twelfth grade levels, the situation was reversed. But, none of these results was statistically significant. Hence, the statistical analysis suggests that efforts must be made to generate interest in mathematics during the last two years of

high school. If girls drop out of mathematics at this stage, their future educational and career options clearly are greatly narrowed. Renewed interest in mathematics at the college sophomore level is almost twice as great for calculus students as it is for non-calculus students. At this level, also, the statistical results suggest that programs must be designed and implemented to encourage qualified women to renew their interest in mathematics.

The statistical results are summarized in Tables II and III.

Table II.

Independence of Sex and Mathematical Confidence

Grade Level	n	X^2	Level of Significance	Results
4	124	.17	.05	not significant
9	60	.4	.05	not significant
12	78	.28	.05	not significant
college sophomores	160	0	.05	not significant

Table III.

Independence of Sex and Interest in Mathematics

Grade Level	n	X^2	Level of Significance	Results
4	124	0	.05	not significant
9	60	2.5	.05	not significant
12	78	7.01	.01	significant
college sophomores	160	.53	.05	not significant

The samples were not sufficiently large to provide a statistical analysis of the effects of various factors on the students' decisions to study advanced mathematics and to pursue mathematical careers. The relationships between the variables in the study and parents' advice, parents' occupations, teachers' advice, guidance counselors' advice and

mathematical background were considered. In all cases, however the subsets were too small for adequate objective analyses. References to these factors appear frequently in the anecdotal report. It is suggested that future studies give further consideration to the relationship between these factors and reasons why qualified women do not pursue mathematical careers.

b. Anecdotal Report

Why, then, do qualified women seem to avoid mathematical careers? The answer to this question becomes more apparent when the replies to interview questions and open-ended questionnaires are analyzed. We found that the answers of women students and practicing mathematicians formed a distinct pattern of barriers toward women in mathematics.

Although fourth grade students are unaware of discrimination, high school girls are extremely conscious of prejudice and peer pressure. They report that parents encourage their sons to continue to study mathematics even when they find it difficult; girls, on the other hand, are encouraged to drop mathematics. Teachers and guidance counselors encourage girls to continue their mathematical studies only if they express great interest in the subject.

Fourth grade girls were somewhat difficult to interview. They were rather shy and gave only brief answers to questions. Generally, they saw no differences between boys and girls in ability or interest in mathematics and no differences in treatment by their teachers. Typical comments were:

"Teachers treat boys and girls the same."

"Everyone needs to learn math to get a job."

"The teacher expects equal work from everyone even if she has to bug the boys more to get it."

"The teacher pays more attention to the boys because they don't pay as much attention to her explanations."

Among the less frequent responses were the statements:

"Boys are more interested in math than girls."

"Girls are smarter."

Ninth grade girls, also, generally believed that boys and girls have equal mathematical ability and that they are treated the same by their teachers. Only one student indicated that she was aware of differences; she commented that, "There is discrimination against women engineers and architects, but I would be willing to fight the battle."

By the time girls reach the twelfth grade, girls' attitudes seem to undergo considerable change. A student who ranked 26th in a class of 310 students had dropped mathematics after second year algebra, in the tenth grade. Her reason was, "My family isn't good in mathematics. We have a lot of trouble with it. I enjoy mathematics--but not in class, where there is pressure to get good grades." She displayed almost no confidence in her mathematical ability and planned to major in English in college although her S.A.T. mathematics score was 30 points higher than her English score. Her remarks were particularly interesting in view of the fact that her father was the Superintendent of Schools.

A second student, who ranked in the top 20 out of 310 seniors, planned to be an engineer. She expressed the opinion that teachers, as far down as fourth and fifth grades, were partial to boys and helped them more. She believed that teachers expect boys to do better than girls in mathematics; and, therefore, boys in fact do better. She felt that reverse discrimination is the present pattern in engineering and that in college there may be discrimination against blacks but not against women.

College sophomores who display an interest in mathematics and plan a mathematical career, are aware of discrimination, while those who are studying nursing, speech pathology, and other female-dominated courses, are relatively unaware of discrimination, less interested in discussing the problem, and more likely to accept a stereotyped role. Typical of the comments made by women students were the following:

> "In retrospect, I realize that there was discrimination even by grade school teachers. Their attitude was characterized by, 'You can try it, but you won't succeed.'"
>
> "My roommate is the top mathematics student in her class. She's more confident than most women, but not as confident as inferior male students. Her high school mathematics teacher encouraged her and helped her get a scholarship to Engineering College. She has felt discrimination from faculty members and from colleagues on her coop job."
>
> "No basic changes in attitudes have taken place, at all. People are being forced to change. Attitudes haven't changed."

And finally,

> "In high school I took the advanced track in mathematics for four years although I never had any encouragement in pursuing it in college or a career.... I did well and looking back feel that had I been encouraged, I may have pursued the interest. I did enjoy math courses--but I felt uncomfortable with the highly competitive males and male-encouraging

> teachers.... High school mathematics was a personal challenge but the loneliness of it steered me away."

Interviews with teachers and counselors from the fourth grade through the twelfth grade produced fairly consistent responses.

We interviewed both male and female fourth grade teachers with a variety of backgrounds. All of them emphatically stated that they do not treat boys different from girls. Most of them believed that sex-role stereotyping begins early, and greatly accelerates during the last two years of high school. Among their comments were the following:

> "Boys seem more eager...get hold of an idea and learn to use it faster...find mathematics challenging. Girls don't like mathematics...find it hard...feel they won't use it. I don't expect more of boys...they just do better. Most girls need extra help."

And,

> "I don't expect boys to learn faster than girls but they do."

The teacher who made this latter comment answered a question concerning changes in societal patterns, with the statement, "At my husband's place of business women are getting men's jobs. Some men are resentful." And, in reply to a question regarding her own experience as a mathematics student, she said, "Trig stopped me. I refused to take calculus."

An outgoing, enthusiastic male teacher with 17 years teaching experience, discussed his experiences with parent conferences. He noted that 75% of the time that a girl receives a C or D in mathematics, her mother would reply that she wasn't good in mathematics, either. In response, the teacher always pointed out that ability in mathematics might not be hereditary. He further reported that in cases where a boy

receives a C or D in mathematics, the mother's explanation is almost invariably, "The boy is lazy." On the whole, mothers want their sons to be successful in mathematics, but they are willing to accept less achievement from their daughters. The teacher who made these observations was the only one of the fourth grade teachers, whom we interviewed, who was enthusiastic in his support of our study. He said that he very much enjoyed being interviewed.

The remaining fourth grade teachers expressed very little interest in the problem of encouraging talented girls to pursue mathematics. In fact, they demonstrated very little recognition that there is a problem. There was general satisfaction with the status quo, and almost no interest in changing societal patterns to increase opportunities for women. When asked to comment on discrimination against women in mathematics, they almost invariably replied by commenting on discrimination against women as school administrators.

Included among the further comments made by fourth grade teachers were these statements:

"Girls are more fearful. It's hard to increase their confidence."

"Girls aren't willing to work all that hard. They don't expect to be breadwinners."

"Girls are as competitive as boys at the 4th grade level."

"Girls get less attention because they're quieter."

"Peer pressure becomes greater as students get older."

"There is more sex-role stereotyping in social studies textbooks than in mathematics textbooks. Men are pictured as inventors; women are pictured as airline stewardesses."

"Boys are more aggressive...more outgoing."

"Girls try harder."

And finally,

"Boys don't care as much as girls when they're wrong. A girl who gives an incorrect answer is much more subdued."

At the ninth grade level, also, teachers and counselors who were interviewed were generally oblivious to issues of discrimination or preferential treatment. In reply to questions about the mathematical ability of girls, teachers tended to avoid the question and to comment, rather, on the outstanding neatness of girls' test papers.

Teachers at the twelfth grade level, too, seemed somewhat obsessed by neatness of test papers, and they, too, highly praised the girls in their classes for displaying this characteristic. The male teachers, who were interviewed, admitted that they expected boys to do better than girls in mathematics, and they believed that parents have similar differences in expectations for their sons compared with their daughters.

One of the twelfth grade counselors, whom we interviewed, was particularly interesting. He was a self assured, confident, articulate young man, with a somewhat limited knowledge of mathematics. Unlike many high school students, he views the role of counselor as very significant in providing academic and career counseling.

Part of our discussion with him was general, in nature. He appeared to be indifferent to the widespread present practice of equating education with job training. He was not dismayed over the fact that included in the 30% of the students in his school, who transfer to a vocational school, are some of the brightest girls in their class. He saw no reason to encourage these girls to consider extending their career options by enrolling in college preparatory courses although he gives this advice to boys under the same circumstances. Our impression was that although this counselor claimed that there was no difference in his

career counseling of boys and girls, he, in fact, encouraged sex-role stereotyping or at least did nothing to discourage it. Girls who did well in mathematics were encouraged by him to study accounting. Among the comments made by this counselor were the following:

"Girls have more difficulty with math than boys. They seek help more frequently."

"The top 10 students in the graduating class include more girls than boys. The top 10 mathematics students, however, would include more boys. It's easier for girls to rank high in their class because they don't take such a heavy load of college preparatory courses."

"Girls drop out of the advanced track in mathematics at the end of the tenth grade because of peer or parental pressure. They don't need that much mathematics. They can choose many careers that don't require mathematics."

He estimated that two-thirds of the boys who are talented in mathematics choose a mathematics-oriented career, but only one-third of the talented girls choose a mathematics-oriented career. Furthermore, more girls than boys fear mathematics and tend to drop out of advanced courses even though they have received high grades.

Interviews with male college professors of mathematics produced a variety of opinions concerning discrimination or lack of it. One professor felt that the Department of Mathematics was less prejudiced than many other departments. When he voiced this opinion to his department head, he was told that "there is more bias than most people realize." In reply to the question, "Is there bias against women faculty members in the Department of Mathematics?", a former department head emphatically stated, "Of course!" At the other end of the scale of opinions, one

professor, just as emphatically said, "I don't believe that discrimination against women in mathematics ever existed.... Their psychological processes are different.... There is a difference in interests and a difference in the way men and women think. There are no outstanding chess players, for example, even in Russia, not because of discrimination, but because of a difference in women's thought processes."

Last January, at the annual AMS-MAA meeting in Washington, D.C., we interviewed the 14 women mathematicians who had been selected in advance of the meeting. We were interested in determining answers to the following questions: What barriers had been placed in the way of their becoming mathematicians? And, how did they manage to overcome these barriers?

In answer to the second question, the women we interviewed were extremely talented--far more talented, we felt, than a random sample of 14 mathematicians would have been. Although they were not always excessively conscious of their ability, they agreed that really good women mathematics students are pushed. And, they had received strong support not only from teachers--at least at the elementary, high school, and undergraduate college levels--but from parents and husbands.

There was great unanimity in their feelings, experiences, and opinions. Typical of statements about their feelings were the following:

"I felt more discrimination as I grew older."

"I felt inadequate in freshman calculus although I received the best grade on the exam."

"It's hard to be objective in retrospect. Am I analyzing past experiences on the basis of what I think now?"

"Have I rationalized discrimination or purposely closed my eyes to it?"

"I think that both men and women feel that women are inferior."

Experiences, from kindergarten through career, also showed remarkable similarities. One professor said that in elementary school she had been discouraged from skipping a grade because she probably wouldn't be able to learn long division. A second professor reported that when she won the award in an undergraduate competitive mathematics examination, she was told that "girls weren't supposed to get the prize." Still another of the women reported that in Graduate School, women had to serve the tea, women were recommended for jobs only at women's colleges, and only certain professors were "willing to take on girls." Job discrimination ranged from the comment by a male colleague, "I don't know why Mrs. A. should be promoted. She's got a husband and he makes a living" to an anecdote reported by a black women mathematician. She had not been offered the chairmanship of a committee even after all the white male committee members had declined because the job involved a stipend and secretarial help. She had never been appointed to a key policy-making committee, but she had been appointed to almost every other committee, and she was <u>always</u> on the social committee.

Opinions, also, were remarkably unanimous. Role models are important. Many women elementary school teachers are terrified of mathematics and hate it. They feel that a mathematician must be a genius or a lunatic. As role models they steer girls away from mathematics. The job market is more favorable to women now than it was six years ago, but the backlash has set in. A department is willing to risk a new Ph.D.; she can always be fired. But, tenure is a different story. And, older women haven't profited from HEW pressures. One department head said that he would hire the worst women he could find so that when she didn't work out, he could say that's what happens when you hire a woman.

The role of teachers and college professors, however, was not always criticized. One college sophomore commented that "teachers encourage good female mathematics students more than the rest of society. They're more open-minded. They're more conscious of high ability and they tend to encourage girls of high ability because they use ability as a criterion more frequently than the rest of society does."

5. Summary, Interpretations, and Conclusions

Statistical results and anecdotal reports supported the conjecture that there is a decrease in girls' interest in mathematics and a sharp increase in societal pressure against women in mathematics during the student's high school years. There were differing opinions, however, on the question of whether mathematics teachers and guidance counselors contribute toward building barriers against women rather than removing society's barriers.

It is suggested that schools and colleges make a greater effort to conduct workshops and design programs to encourage qualified girls to pursue careers in mathematics. Since the greatest drop-out of mathematically qualified girls occurs during the last two years of high school, special attention should be given to implementing such programs at the tenth grade level. Attention should also be given to designing in-service education programs for teachers and guidance counselors at all levels since there is some evidence that they presently exert a negative influence toward girls as mathematicians.

Previous studies dealing with prejudice have indicated that instruments and interviews used to measure attitudes frequently effect changes in attitudes. Although there was no attempt to measure such changes resulting from this study, it is hoped that the use of the instruments

and interviews did themselves encourage a greater number of qualified girls to pursue careers in mathematics.

Results of the study, both conclusive and inconclusive, suggested the following questions for future investigation:

1. A longitudinal study of girls now in the fourth grade to determine changes in individuals or groups of individuals with respect to mathematical confidence, interest in mathematics, academic plans, and career goals; and causes of these changes.
2. A study of the relationship between the advice of parents and teachers and boys' decisions; and the relationship between the advice of parents and teachers and girls' decisions.
3. A comparison of attitudes toward women in mathematics among various ethnic groups.

Finally, in spite of the barriers and the backlash, there is a feeling that times are changing. Girls show less fear of mathematics than did women students before the 1960's. Universities are being pushed by HEW.

The January, 1975 meeting of the Association for Women in Mathematics, at which discrimination against women was discussed, drew a hugh standing-room-only crowd, including quite a few male mathematicians. The question and answer period was sparked with lively enthusiasn and eagerness for change. The National Science Foundation has developed plans to fund workshops for women at the various collegiate levels to interest them in scientific careers and programs for female college graduates to retrain them for careers in science. The 1976 annual meeting of the National Council of Teachers of Mathematics had several

sessions scheduled to discuss various aspects of the problem of encouraging talented girls to study mathematics.

And a number of competent female mathematicians are emerging. It is, therefore, not unrealistic to hope along with the editors of Great Currents of Mathematical Thought that "the growth of female education, the overthrow of prejudices, the profound changes in the kind of life and in the role assigned to women during the last few years will doubtless bring about a revision of her position in science. Then we shall see in what measure she can, as the equal of man, emerge from the role of the excellent pupil or the perfect collaborator, and join those of our scientists whose work has opened new paths and bears the mark of genius."

APPENDIX A

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Note of Explanation for

Appendices B, C, D

Confidence in doing mathematics is measured by:

Questions 2, 5, 7, 15, 21, 24, 25, 26, 27, 28, 30 of the

Fourth Grade Survey,
Ninth Grade Questionnaire,
Twelfth Grade Questionnaire,
College Sophomore Opinionnaire.

Interest in mathematics is measured by:

Questions 1, 4, 6, 9, 10, 12, 14, 16, 17, 19, 20 of the

Fourth Grade Survey,
Ninth Grade Opinionnaire,
Twelfth Grade Opinionnaire,
College Sophomore Questionnaire.

APPENDIX B

Pilot Project - Stage 1

Interview Questions

To (4th Grade Students)

1. What is your favorite subject in school?

2. Do you enjoy arithmetic?

3. What is the most fun in arithmetic?

4. Who is the best in arithmetic - the boys or the girls? both?

5. Can you tell me some jobs for which you need to know a lot of math?

6. Are there any of these jobs, for which you need to know a lot of math, of interest to you?

Interview Questions

Ninth and Twelfth Grade Students

(High School)

1. ...at do you enjoy most about your math classes? Least?

2. Have you been aware of any differences in the way boys and girls are treated by your math teacher?

3. Do you feel that you were treated differently by male and female math teachers?

4. Do you feel any pressure to let the boys in your math classes answer first?

5. Does your math teacher call on the girls as much as the boys?

6. Does your math teacher help the girls as much as the boys?

7. Have you always been good in math?

8. Was your academic ability, and specifically your math ability, rewarded differently by your teachers in grades 1-6 compared with grades 7-12?

9. Have you considered a career in math or in some related field?

10. Have you discussed your future plans with your teachers, your counselors, friends, parents?

11. Have any of the people you have discussed future plans with encouraged you in the direction of a math career or discouraged you in this direction?

12. Do you feel pressure from your friends to either study mathematics or not to study mathematics?

Interview Questions

Ninth Grade

Junior High School

1. List subjects you're taking this year, in the order in which you like them.

2. What did you like best about algebra?

3. Have you always done well in mathematics?

4. How much mathematics do you expect to take in the future?

5. Do you enjoy mathematics homework? Or, is the homework drudgery?

6. Do you work hard on problems you can't solve? Or, do you ask for help, almost immediately?

7. Where do you think you rank in your mathematics class? Why?

8. How do you think your teacher would rank you in your mathematics class?

9. After you've taken a mathematics test, can you usually estimate your grade?

10. Is the atmosphere in your mathematics class relaxed or tense?

11. When there is a discussion in a mathematics class, do you actively participate? Answer questions? Why or why not?

12. What qualities are necessary for success in mathematics? Which of these qualities do you have?

Interview Questions

Twelfth Grade

Senior High School

1. What is your favorite subject in school?
2. How important is persistence to success in mathematics?
3. How does a teacher affect a student's success in mathematics?
4. List your school subjects in the order of your interest in them.
5. What aspect of mathematics do you find most difficult?
6. How do you rate yourself as a mathematics student relative to other students in your class? Why?
7. How much mathematics do you expect to take in the future?
8. How do you think your teacher would rate you as a mathematics student?
9. Do you volunteer often in class? What motivates you to volunteer?
10. Have you ever felt "completely lost" in a mathematics course? What did you do to overcome this problem?
11. What are the qualities of a successful mathematics student? Which of these qualities do you possess?
12. How does a good grade on a test affect your attitude toward mathematics? your motivation? your study habits? How does a low grade on a test affect your attitude toward mathematics? your motivation? your study habits?
13. To what extent do you rely on help from the teacher outside of class?
14. Are boys more aggressive in class participation?
15. If you enjoy mathematics what has influenced your enjoyment?
16. Describe the atmosphere of your mathematics class--tense or relaxed?
17. Do you find any differences in teaching techniques between men and women mathematics teachers?
18. Is it a handicap to be a <u>woman</u> in a scientific career?
19. Has mathematics always been easy for you?
20. How does the personality of the teacher affect the success of the student?
21. Are you a patient student?
22. Do you get discouraged easily if you have difficulty solving a mathematics problem? What do you do to overcome this discouragement?

Interview Questions

Twelfth Grade

1. What is your favorite subject in school? Why?

2. If you were to list school subjects in the order of interest, in what position would you place mathematics?

3. Do you find problem solving easy? challenging? frustrating?

4. What uses do you see for mathematics in terms of your life? your future plans--educational, career?

5. How do you rate yourself as a mathematics student, relative to other students in your class?

6. Do your teachers and/or guidance counselors encourage you to pursue further work in mathematics?

7. How many mathematics courses do you expect to take? Why?

8. How do you think your teachers rate your mathematical ability? Do you agree?

9. After you have taken a mathematics test, can you accurately predict your grade?

10. What do you think are the qualities of a good mathematician? (i.e., mathematical aptitude, patience, perseverance, creativity, etc.) Which of these qualities do you possess?

11. How much time do you spend on mathematics, relative to other school subjects?

12. Do you enjoy doing mathematics homework or do you find it drudgery? Why?

13. What do you consider to be the most important factors which have influenced your interest (or lack of interest) in mathematics?

Interview Questions

Calculus Students

1. Do you like mathematics?
2. What are your career plans?
3. Why did you take calculus?
4. What further mathematics courses do you plan to take?
5. How do you rate yourself as a mathematics student in relation to your high school graduation class? your calculus class? your own ideals?
6. What do you think are the characteristics of a good mathematician? Which of these characteristics do you have?
7. After you have taken a quiz or exam, can you usually estimate the grade you will receive?
8. How much time/week, on the average, did you spend working calculus problems? Did you find the assignments challenging? frustrating?
9. Who influenced your career choice? In what way?
10. Who advised you to take calculus? Why?
11. Did you attend class regularly?
12. If you missed class, were you able to read the textbook and understand it, without any help?
13. Did you ever help other students study calculus? When did you help? Why?
14. Would you be a good tutor for any mathematics course you've already had? Why or why not?
15. Do you think you have sufficient mathematical ability to succeed in <u>any</u> mathematics course you might choose to take, in the future?
16. If volunteers are requested to demonstrate problems in class, do you volunteer?
17. How would you rate your confidence in doing mathematics? Your interest in mathematics?

Questionnaire

Ninth Grade, Twelfth Grade

Directions: Write 2 or 3 sentences in answer to each of the following questions.

1. List the subjects you are taking this year, in the order in which you like them. Briefly, tell why you listed them in this order?

2. What do you like best about math?

3. Where do you think you rank in your mathematics class? Why? Where do you think your teacher would rank you in your mathematics class?

4. When there is a discussion in a mathematics class, do you actively participate? Answer questions? Why or why not?

5. What qualities are necessary to success in mathematics? Which of these qualities do you have?

Questionnaire

Calculus Students

1. Do you like mathematics? Why or why not?

2. What do you think are the characteristics of a good mathematician? Which of these characteristics do you have?

3. What are your career plans? Who influenced your career choice? In what way did he (they) influence you?

4. How would you define confidence in doing mathematics? How would you rate your own confidence in doing mathematics?

5. How would you define interest in doing mathematics? How would you rate your own interest in doing mathematics?

APPENDIX C

Pilot Project - Stage 2

Ninth Grade, Twelfth Grade

MATHEMATICS OPINIONNAIRE

Directions: Each statement below represents a belief or a behavior of a particular high school student. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree) and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure none of the other responses applies to you.

		SA	A	U	D	SD
1.	I enjoy working on the difficult problems in a homework assignment.	O	O	O	O	O
2.	I do not like mathematics because it is so difficult.	O	O	O	O	O
3.	Mathematics is fun.	O	O	O	O	O
4.	I would like to read a biography of a famous mathematician.	O	O	O	O	O
5.	I would never take a mathematics course as an elective.	O	O	O	O	O
6.	I would like to achieve fame by solving an unsolved mathematics problem.	O	O	O	O	O
7.	I have no patience for doing mathematics.	O	O	O	O	O
8.	I often get sleepy in mathematics class.	O	O	O	O	O
9.	I don't like to work with numbers.	O	O	O	O	O
10.	Mathematics is boring.	O	O	O	O	O
11.	My ability in mathematics helps me to solve real life problems.	O	O	O	O	O
12.	I like crossword puzzles and word games better than mathematics puzzles.	O	O	O	O	O
13.	If a problem is difficult I continue to work on it until I solve it.	O	O	O	O	O
14.	I have the patience to work on a mathematics problem for a long time.	O	O	O	O	O
15.	I am always eager to learn if my solutions to homework problems are correct.	O	O	O	O	O

		SA	A	U	D	SD
16.	I dislike my mathematics class.	0	0	0	0	0
17.	I don't like to explain homework problems to the rest of the class.	0	0	0	0	0
18.	I have never liked mathematics.	0	0	0	0	0
19.	I would rather try to discover mathematical principles than have them explained to me.	0	0	0	0	0
20.	If I cannot solve a problem, I rest and return to it later.	0	0	0	0	0
21.	I spend less time on mathematics assignments than I spend on homework for any other courses.	0	0	0	0	0
22.	I enjoy working with abstract ideas.	0	0	0	0	0
23.	I plan to select a career that does not involve mathematics.	0	0	0	0	0
24.	I plan to study mathematics in college.	0	0	0	0	0
25.	My only reason for studying mathematics is that it is a requirement for college.	0	0	0	0	0
26.	I would like to have mathematics the first period of the day and my more interesting classes later in the day.	0	0	0	0	0
27.	I continue to analyze a mathematics problem until I completely understand what is required to answer the question.	0	0	0	0	0
28.	I find mathematics challenging.	0	0	0	0	0
29.	I don't like science courses that involve using mathematics.	0	0	0	0	0
30.	I am glad when there is an assembly during mathematics class.	0	0	0	0	0
31.	I have found many interesting mathematics books in the school library.	0	0	0	0	0
32.	When I'm working on a mathematics problem I'm not easily distracted.	0	0	0	0	0
33.	I spend less time on mathematics than any other school subject.	0	0	0	0	0
34.	I am intrigued by the logical thinking required in mathematics.	0	0	0	0	0

MATHEMATICS QUESTIONNAIRE

Ninth Grade, Twelfth Grade

Directions: Each statement below represents a belief or a behavior exhibited by high school students. You are asked to express the extent to which you personally agree or disagree that the statement describes <u>you</u>. Responses are to be made on a five-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree), and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response <u>only</u> if you are sure that none of the other responses applies to you.

		SA	A	U	D	SD
1.	I have an analytical mind.	O	O	O	O	O
2.	I usually understand a new topic the first time it is explained.	O	O	O	O	O
3.	I expect to score high on the mathematics section of the Scholastic Aptitude Test (SAT).	O	O	O	O	O
4.	It takes a long time for me to finish a homework assignment.	O	O	O	O	O
5.	I never answer questions in mathematics class.	O	O	O	O	O
6.	I learn mathematics rapidly and easily.	O	O	O	O	O
7.	I have always been a good mathematics student.	O	O	O	O	O
8.	Mathematics is my hardest subject in school.	O	O	O	O	O
9.	I have no talent for mathematics.	O	O	O	O	O
10.	I never feel that I completely understand the work in my mathematics class.	O	O	O	O	O
11.	I have imagination and creative ability in mathematics.	O	O	O	O	O
12.	I understand explanations of new topics faster than most students in my class.	O	O	O	O	O
13.	After I have solved a mathematics problem, I feel sure that the solution is correct.	O	O	O	O	O
14.	I feel nervous when I take a mathematics test.	O	O	O	O	O
15.	If I need help on a mathematics problem, I require a tutor with a great deal of patience.	O	O	O	O	O

	SA	A	U	D	SD
16. I will work a problem on the blackboard and explain it to the class even if I haven't previously solved it.	0	0	0	0	0
17. I frequently don't have any idea how to work a homework problem.	0	0	0	0	0
18. I sometimes point out mistakes when the teacher demonstrates a mathematics problem.	0	0	0	0	0
19. It is difficult to read a mathematics textbook.	0	0	0	0	0
20. I study a great deal for mathematics tests.	0	0	0	0	0
21. The other students in my class expect me to solve the difficult problems.	0	0	0	0	0
22. My teacher would rank me among the top 10% of the students in my mathematics class.	0	0	0	0	0
23. I find it difficult to remember mathematical formulas.	0	0	0	0	0
24. I can solve most of the mathematics problems which are assigned.	0	0	0	0	0
25. After several unsuccessful attempts to solve a mathematics problem, I get disgusted.	0	0	0	0	0
26. I make frequent careless mistakes in working simple problems.	0	0	0	0	0
27. After I have taken a test, I can usually estimate my grade accurately.	0	0	0	0	0
28. In class, I never volunteer to explain homework problems.	0	0	0	0	0
29. I worry about my grade on almost every mathematics test.	0	0	0	0	0
30. I have a knack for selecting the correct method or formula to solve a particular problem.	0	0	0	0	0
31. I frequently help my friends who have difficulty with mathematics.	0	0	0	0	0
32. I often need help in doing mathematics assignments.	0	0	0	0	0
33. If I tried, I could be one of the best mathematics students in my class.	0	0	0	0	0
34. I believe that I would do well in any mathematics course I chose to take.	0	0	0	0	0
35. I don't have a logical mind.	0	0	0	0	0

MATHEMATICS OPINIONNAIRE

College Sophomores

____ Freshman ____ Sophomore ____ Junior ____ Senior

List the college mathematics courses which you have completed or in which you are now enrolled.

_____ _____

_____ _____

_____ _____

Directions: Each statement below represents a belief or a behavior of a particular college student of mathematics. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree), and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure none of the other responses applies to you.

		SA	A	U	D	SD
1.	When I disagree with another student over the solution to a problem, I'm sure that I'm right.	O	O	O	O	O
2.	I often feel that mathematics assignments are overwhelmingly long and difficult.	O	O	O	O	O
3.	If I am confronted with a new mathematical situation, I can cope with it because I have a good background in mathematics.	O	O	O	O	O
4.	I work on mathematics assignments first because I know that I can finish them rapidly and easily.	O	O	O	O	O
5.	I have greater talent in academic areas other than mathematics.	O	O	O	O	O
6.	I am not capable of learning advanced mathematics.	O	O	O	O	O
7.	I get flustered if I am confronted with a problem different from the problems worked in class.	O	O	O	O	O
8.	I do not attempt to work a problem without referring to the textbook or class notes.	O	O	O	O	O
9.	I can draw upon a wide variety of mathematical techniques to solve a particular problem.	O	O	O	O	O
10.	I do not feel that I have a good working knowledge of the mathematics courses I have taken so far.	O	O	O	O	O
11.	Mathematics is difficult.	O	O	O	O	O
12.	I feel afraid when I begin a mathematics course.	O	O	O	O	O

		SA	A	U	D	SD
13.	I have not mastered the basic mathematical skills.	O	O	O	O	O
14.	After I have written the answer to a quiz problem, I do not find it necessary to reread the solution or check for possible errors.	O	O	O	O	O
15.	I believe that if I work long enough on a mathematics problem, I will be able to solve it.	O	O	O	O	O
16.	I have forgotten many of the mathematical concepts which I have learned.	O	O	O	O	O
17.	After I have seen the solution to a problem, I am able to solve a similar problem any time I encounter it.	O	O	O	O	O
18.	I look forward to attending classes in mathematics.	O	O	O	O	O
19.	I begin to work on a mathematics problem by telling myself that I can solve it.	O	O	O	O	O
20.	I seldom participate in discussions in mathematics classes.	O	O	O	O	O
21.	I do not hesitate to interrupt or correct a teacher or student who makes an incorrect mathematical statement.	O	O	O	O	O
22.	I learn mathematics by understanding the underlying logical principles, not by memorizing rules.	O	O	O	O	O
23.	I can easily follow mathematical explanations of problems which arise in science class.	O	O	O	O	O
24.	If I cannot solve a mathematics problem, at least I know a general method of attacking it.	O	O	O	O	O
25.	I enjoy solving mathematics problems.	O	O	O	O	O
26.	When I begin a mathematics assignment, I feel that I shall be able to work the problems.	O	O	O	O	O
27.	I like to do mathematics because I like to accomplish a task that most people regard as difficult.	O	O	O	O	O
28.	I would hesitate tutoring anyone in mathematics.	O	O	O	O	O
29.	I make a considerable number of errors in working mathematics problems.	O	O	O	O	O
30.	It is difficult to understand the language and symbolism of mathematics.	O	O	O	O	O
31.	I cannot get good grades in mathematics without doing a great deal of work.	O	O	O	O	O
32.	I answer mathematics questions which are asked by other students.	O	O	O	O	O
33.	I often look at a set of mathematics problems					

MATHEMATICS QUESTIONNAIRE

College Sophomores

____ Freshman ____ Sophomore ____ Junior ____ Senior

List the college mathematics courses which you have completed or in which you are now enrolled.

_____ _____

_____ _____

_____ _____

Directions: Each statement below represents a belief or a behavior exhibited by college students of mathematics. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree), SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure that none of the other responses applies to you.

		SA	A	U	D	SD
1.	I continue to read and study a new mathematical concept until I completely understand it.	O	O	O	O	O
2.	Getting the correct answers encourages me to work additional problems.	O	O	O	O	O
3.	I have found very few uses for mathematics in other academic areas.	O	O	O	O	O
4.	I am willing to devote considerable time to learning mathematics even if my leisure time is decreased.	O	O	O	O	O
5.	I have a greater interest in learning how to think than in learning what to think.	O	O	O	O	O
6.	I prefer mathematics problems which are more challenging than those in most textbooks.	O	O	O	O	O
7.	I enjoy doing mathematics for its own sake, regardless of its potential usefulness.	O	O	O	O	O
8.	I see no value in studying the relationships among various branches of mathematics.	O	O	O	O	O
9.	I seldom ask questions involving generalizations, unifying concepts, or applications.	O	O	O	O	O
10.	I do not plan to study advanced mathematics.	O	O	O	O	O
11.	I sometimes work ahead of the class.	O	O	O	O	O
12.	I have never studied a mathematical topic outside of formal class work.	O	O	O	O	O
13.	I frequently ask questions involving generalizations, unifying concepts, or applications.	O	O	O	O	O
14.	I enjoy following the logical development of a mathematical proof.	O	O	O	O	O
15.	I do not have the patience for mathematical computation.	O	O	O	O	O

		SA	A	U	D	SD
16.	I have no talent in mathematics.	0	0	0	0	0
17.	I am more interested in learning the "how" than the "why" of mathematics.	0	0	0	0	0
18.	Mathematics problems are a challenge; solving problems provides satisfactions similar to those of winning a battle.	0	0	0	0	0
19.	I learn mathematics so that I can use it, not just to pass an exam.	0	0	0	0	0
20.	I try hard to understand mathematics.	0	0	0	0	0
21.	I have never read a mathematics book other than my textbooks.	0	0	0	0	0
22.	I can spend many hours working on a single mathematics problem without getting tired or frustrated.	0	0	0	0	0
23.	Working on mathematics problems is drudgery.	0	0	0	0	0
24.	I believe that learning procedures to solve problems is more important than getting the correct answer.	0	0	0	0	0
25.	I do not try to learn mathematics on my own.	0	0	0	0	0
26.	I never work on more challenging problems than those which are assigned.	0	0	0	0	0
27.	Mathematics is a very useful tool in the technology of the twentieth century.	0	0	0	0	0
28.	Problem solving fascinates me.	0	0	0	0	0
29.	My leisure reading does not include mathematics books.	0	0	0	0	0
30.	I prefer word games and puzzles rather than mathematical puzzles.	0	0	0	0	0
31.	Mathematics is boring.	0	0	0	0	0
32.	I spend more time on mathematics than any other course because I enjoy working extra problems or working ahead of the class.	0	0	0	0	0
33.	Watching an ice skater would arouse my curiosity about deriving a function for the two dimensional pattern of the tracks left in the ice.	0	0	0	0	0
34.	I do not care about learning the principles of logic underlying mathematics.	0	0	0	0	0
35.	Mathematics is not my favorite academic subject.	0	0	0	0	0
36.	It isn't necessary for everyone to know mathematics.	0	0	0	0	0
37.	I work on mathematics primarily because I enjoy it, not because I am being graded in the course.	0	0	0	0	0
38.	I do not expect to use mathematics in my chosen career.	0	0	0	0	0

APPENDIX D

Questionnaires Used in The Study

Fourth Grade Survey

____ Boy Father's Occupation _____

____ Girl Mother's Occupation _____

Some of the jobs I think I'd like when I finish school are:

1. _____
2. _____
3. _____
4. _____
5. _____

Answer each of the following questions by filling in the circle under "Yes", "?", or "No". Fill in the circle under "?" only if you cannot honestly answer "Yes" or "No."

		Yes	?	No
1.	I like to study math.	0	0	0
2.	Math should be easier.	0	0	0
3.	I do my best in school.	0	0	0
4.	Math is boring.	0	0	0
5.	My teachers think I do good work.	0	0	0
6.	Math is one of my favorite subjects.	0	0	0
7.	I am pretty good in math.	0	0	0
8.	I probably won't learn much this year.	0	0	0
9.	We spend too much time on math.	0	0	0
10.	I like math better than I did last year.	0	0	0
11.	I play around instead of studying.	0	0	0
12.	I get bored doing math for a long time.	0	0	0
13.	We should have more holidays.	0	0	0
14.	I don't like math.	0	0	0
15.	Everyone knows I am smart in math.	0	0	0
16.	People need to know math to do most jobs.	0	0	0
17.	Math is the most important thing you learn in school.	0	0	0
18.	I look forward to coming to school.	0	0	0
19.	I play around when I'm supposed to study math.	0	0	0
20.	I daydream during math class.	0	0	0
21.	I do my best in math.	0	0	0
22.	School is a nice place to be.	0	0	0

	Yes	?	No
23. Most of the kids in my class are mean.	0	0	0
24. I'm not doing very well in math.	0	0	0
25. My teacher thinks I do good work in math.	0	0	0
26. This is a good year in math for me.	0	0	0
27. I know more math than most kids my age.	0	0	0
28. Math problems are too hard.	0	0	0
29. I wish kids didn't have to go to school.	0	0	0
30. My parents think I'm good in math.	0	0	0

Interviews

Fourth Grade Girls

1. Do you enjoy working mathematics problems?

2. How do you compare with other girls in your class? with boys in your class?

3. What jobs are you interested in? Which of them involve a great deal of mathematics in school?

4. Do you plan to take a great deal of mathematics in school?

5. Is there any difference in mathematical ability between boys and girls?

6. Is there any difference in the way boys and girls behave in class?

7. Do teachers treat boys differently from girls? Do they ask more questions of either boys or girls?

8. Do you answer questions voluntarily in class or do you wait to be asked?

9. Have you ever discussed jobs with your parents? What advice have they given you?

10. Would you mind being the only girl in a mathematics class?

11. Who are the best students in your class?

12. Does your teacher expect girls to do as well as boys?

Interviews

Fourth Grade Teachers

1. What differences do you notice in the performance of boys and girls in mathematics class?

2. Are boys more willing than girls to volunteer answers or participate in discussions?

3. What differences do you see in attitudes of boys and girls in mathematics class?

4. Do you expect more of boys than of girls?

5. Are you aware of any peer pressure on girls to be less aggressive than boys in asking or answering questions?

6. Do parents have different expectations for their daughters than they have for their sons?

7. Have you ever given preferred treatment to girls? In what way?

8. Did you ever experience any discrimination against women in your own education?

9. Do you think that elementary and secondary school teachers, in the past few years, have changed their attitudes toward girls studying mathematics?

10. Summarize your views on society's barriers against women in mathematics. To what extent do educators at various levels build barriers or attempt to remove them? Have you perceived any significant changes in attitudes in the past few years? What role should educators play in removing barriers against women in mathematics? How can these changes be effected?

Ninth Grade Survey

____ Male Father's Occupation _____

____ Female Mother's Occupation _____

1. What mathematics courses do you plan to take in high school?

2. What mathematics courses do you plan to take in college?

3. List the career or careers which you are currently considering. Be as specific as you can.

4. Have your parents influenced your choice of careers? If so, explain how they have influenced you.

5. Have your teachers influenced your choice of careers? If so, explain how they have influenced you.

6. Have your guidance counselors influenced your choice of careers? If so, explain how they have influenced you.

MATHEMATICS QUESTIONNAIRE

Ninth Grade

Directions: Each statement below represents a belief or a behavior exhibited by high school students. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree) and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure that none of the other responses applies to you.

		SA	A	U	D	SD
1.	I seldom understand a new topic the first time it is explained.	O	O	O	O	O
2.	I expect to score high on the mathematics section of the Scholastic Aptitude Test (SAT)	O	O	O	O	O
3.	It takes a long time for me to finish a homework assignment.	O	O	O	O	O
4.	I never answer questions in mathematics class.	O	O	O	O	O
5.	I learn mathematics rapidly and easily.	O	O	O	O	O
6.	Mathematics is my hardest subject in school.	O	O	O	O	O
7.	I have no talent for mathematics.	O	O	O	O	O
8.	I have imagination and creative ability in mathematics.	O	O	O	O	O
9.	I understand explanations of new topics faster than most students in my class.	O	O	O	O	O
10.	I feel nervous when I take a mathematics test.	O	O	O	O	O
11.	I will work a problem on the blackboard and explain it to the class even if I haven't previously solved it.	O	O	O	O	O
12.	I frequently don't have any idea how to work a homework problem.	O	O	O	O	O
13.	I study a great deal for mathematics tests.	O	O	O	O	O
14.	My teacher would rank me among the top 10% of the students in my mathematics class.	O	O	O	O	O

	SA	A	U	D	SD
15. I can solve most of the mathematics problems which are assigned.	O	O	O	O	O
16. In class, I never volunteer to explain homework problems.	O	O	O	O	O
17. I worry about my grade on almost every mathematics test.	O	O	O	O	O
18. I have a knack for selecting the correct method or formula to solve a particular problem.	O	O	O	O	O
19. I frequently help my friends who have difficulty with mathematics.	O	O	O	O	O
20. I often need help in doing mathematics assignments.	O	O	O	O	O
21. If I tried, I could be one of the best mathematics students in my class.	O	O	O	O	O
22. I believe that I would do well in any mathematics course I chose to take.	O	O	O	O	O

MATHEMATICS OPINIONNAIRE

Ninth Grade

Directions: Each statement below represents a belief or a behavior of a particular high school student. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree) and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure none of the other responses applies to you.

		SA	A	U	D	SD
1.	I enjoy working on the difficult problems in a homework assignment.	O	O	O	O	O
2.	I do not like mathematics because it is so difficult.	O	O	O	O	O
3.	I would like to read a biography of a famous mathematician.	O	O	O	O	O
4.	I would never take a mathematics course as an elective.	O	O	O	O	O
5.	I would like to achieve fame by solving an unsolved mathematics problem.	O	O	O	O	O
6.	I have no patience for doing mathematics.	O	O	O	O	O
7.	I often get sleepy in mathematics class.	O	O	O	O	O
8.	I like to work with numbers.	O	O	O	O	O
9.	Mathematics is boring.	O	O	O	O	O
10.	My ability in mathematics helps me to solve real life problems.	O	O	O	O	O
11.	If a problem is difficult, I continue to work on it until I solve it.	O	O	O	O	O
12.	I have the patience to work on a mathematics problem for a long time.	O	O	O	O	O
13.	I like my mathematics class.	O	O	O	O	O
14.	I don't like to explain homeowrk problems to the rest of the class.	O	O	O	O	O

		SA	A	U	D	SD
15.	I have never liked mathematics.	O	O	O	O	O
16.	I plan to select a career that does not involve mathematics.	O	O	O	O	O
17.	I plan to study mathematics in college.	O	O	O	O	O
18.	My only reason for studying mathematics is that it is a requirement for college.	O	O	O	O	O
19.	I continue to analyze a mathematics problem until I completely understand what is required to answer the question.	O	O	O	O	O
20.	I don't like science courses that involve using mathematics.	O	O	O	O	O
21.	I am glad when there is an assembly during mathematics class.	O	O	O	O	O
22.	When I'm working on a mathematics problem I'm not easily distracted.	O	O	O	O	O

Interviews

Ninth Grade Teachers

1. What differences do you notice in the performance of boys and girls in mathematics class?

2. Are boys more willing to answer and go to the board than girls?

3. What differences do you see in attitudes of girls and boys in mathematics?

4. Do you consciously or perhaps unconsciously expect more of boys than of girls?

5. What methods do you use to encourage maximum performance from your students?

6. How important is neatness in doing mathematics problems?

7. Are girls generally neater than boys in their written work?

8. Are you aware of any spoken or unspoken peer pressure on girls to be less aggressive than boys in answering in mathematics class?

9. What do parents that you have talked with seem to expect of their daughters vs. their expectations for their sons?

10. Did you experience any prejudice in your own educational experiences training you for your career in mathematics?

Twelfth Grade Survey

____ Male Father's Occupation _____

____ Female Mother's Occupation _____

1. What mathematics courses do you plan to take in college?

2. List the career or careers which you are currently considering. Be as specific as you can.

3. Have your parents influenced your choice of careers? If so, explain how they have influenced you.

4. Have your teachers influenced your choice of careers? If so, explain how they have influenced you.

5. Have your guidance counselors influenced your choice of careers? If so, explain how they have influenced you.

MATHEMATICS QUESTIONNAIRE

Twelfth Grade

Directions: Each statement below represents a belief or a behavior exhibited by high school students. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a five-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree) and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure that none of the other responses applies to you.

		SA	A	U	D	SD
1.	I usually understand a new topic the first time it is explained.	O	O	O	O	O
2.	I expect to score high on the mathematics section of the Scholastic Aptitude Test (SAT).	O	O	O	O	O
3.	It takes a long time for me to finish a homework assignment.	O	O	O	O	O
4.	I learn mathematics rapidly and easily.	O	O	O	O	O
5.	I have always been a good mathematics student.	O	O	O	O	O
6.	Mathematics is my hardest subject in school.	O	O	O	O	O
7.	I have no talent for mathematics.	O	O	O	O	O
8.	I never feel that I completely understand the work in my mathematics class.	O	O	O	O	O
9.	I have imagination and creative ability in mathematics.	O	O	O	O	O
10.	I understand explanations of new topics faster than most students in my class.	O	O	O	O	O
11.	After I have solved a mathematics problem, I feel sure that the solution is correct.	O	O	O	O	O
12.	I feel nervous when I take a mathematics test.	O	O	O	O	O
13.	I frequently don't have any idea how to work a homework problem.	O	O	O	O	O
14.	My teacher would rank me among the top 10% of the students in my mathematics class.	O	O	O	O	O

	SA	A	U	D	SD
15. I find it difficult to remember mathematical formulas.	O	O	O	O	O
16. After several unsuccessful attempts to solve a mathematics problem, I get disgusted.	O	O	O	O	O
17. In class, I never volunteer to explain homework problems.	O	O	O	O	O
18. I worry about my grade on almost every mathematics test.	O	O	O	O	O
19. I have a knack for selecting the correct method or formula to solve a particular problem.	O	O	O	O	O
20. I frequently help my friends who have difficulty with mathematics.	O	O	O	O	O
21. I often need help in doing mathematics assignments.	O	O	O	O	O
22. I believe that I would do well in any mathematics course I chose to take.	O	O	O	O	O

MATHEMATICS OPINIONNAIRE

Twelfth Grade

Directions: Each statement below represents a belief or a behavior of a particular high school student. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a five-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D(Disagree) and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure none of the other responses applies to you.

		SA	A	U	D	SD
1.	I enjoy working on the difficult problems in a homework assignment.	O	O	O	O	O
2.	Mathematics is fun.	O	O	O	O	O
3.	I would never take a mathematics course as an elective.	O	O	O	O	O
4.	I would like to achieve fame by solving an unsolved mathematics problem.	O	O	O	O	O
5.	I have no patience for doing mathematics.	O	O	O	O	O
6.	I don't like to work with numbers.	O	O	O	O	O
7.	Mathematics is boring.	O	O	O	O	O
8.	My ability in mathematics helps me to solve real life problems.	O	O	O	O	O
9.	If a problem is difficult I continue to work on it until I solve it.	O	O	O	O	O
10.	I have the patience to work on a mathematics problem for a long time.	O	O	O	O	O
11.	I am always eager to learn if my solutions to homework problems are correct.	O	O	O	O	O
12.	I dislike my mathematics class.	O	O	O	O	O
13.	I don't like to explain homework problems to the rest of the class.	O	O	O	O	O
14.	I have never liked mathematics.	O	O	O	O	O

		SA	A	U	D	SD
15.	I spend less time on mathematics assignments than I spend on homework for any other courses.	O	O	O	O	O
16.	I plan to select a career that does not involve mathematics.	O	O	O	O	O
17.	I plan to study mathematics in college.	O	O	O	O	O
18.	My only reason for studying mathematics is that it is a requirement for college.	O	O	O	O	O
19.	I would like to have mathematics the first period of the day and my more interesting classes later in the day.	O	O	O	O	O
20.	I continue to analyze a mathematics problem until I completely understand what is required to answer the question.	O	O	O	O	O
21.	I find mathematics challenging.	O	O	O	O	O
22.	I don't like science courses that involve using mathematics.	O	O	O	O	O
23.	I am glad when there is an assembly during mathematics class.	O	O	O	O	O
24.	When I'm working on a mathematics problem I'm not easily distracted.	O	O	O	O	O
25.	I spend less time on mathematics than any other school subject.	O	O	O	O	O

Interviews

Ninth and Twelfth Grade Girls

1. What careers are you currently considering? Why?

2. Who has encouraged you to choose this career? Who has discouraged you? In what way?

3. How does mathematics fit into your career plans? How do your parents feel about a career for you in a field related to mathematics?

4. Have mathematics teachers, with whom you have come in contact, treated boys differently from girls in class? In what way was the treatment different? Do teachers ask more questions of either boys or girls? Do teachers expect girls to do as well as boys?

5. Are you planning to study a considerable amount of mathematics in the future? If so, are teachers more or less supportive than your friends of this decision? More or less supportive than your family?

6. Is mathematics less feminine than art? English?

7. How would you react to being the only girl in a mathematics class? In any other class?

8. Who makes the best grades in your mathematics class? How do you compare with the other girls? With the boys?

9. Do you answer questions voluntarily in class or do you wait to be asked directly?

10. What differences do you see in the performance of boys and girls in mathematics class?

11. Do you know any women in mathematics careers?

12. Have guidance counselors played any part in your educational or career decisions?

13. Has the possibility of discrimination against women influenced your thinking about a future career? In what way?

14. Have you ever been warned of probable discrimination against

Interviews

Twelfth Grade Teachers

1. To what extent do you feel that you influence the career choices of your students? Explain.

2. In your classes, do you treat boys different from girls. If so, in what way is the treatment different?

3. To what extent do you feel that you influence your students to continue or discontinue their study of mathematics? Explain.

4. Has the poasibility of discrimination against women influenced your counseling girls about future careers? In what way?

5. Have you ever warned girls of probable discrimination against them? Under what circumstances?

6. Have you ever given preferred treatment to girls? In what way?

7. Has the possibility of preferred treatment influenced your counseling girls about future education or careers? In what way?

8. In your Department of Mathematics, is there discrimination against girls as students? against women as teachers? Was there discrimination at any time? What steps were taken to solve the problem?

9. Do you think that elementary and secondary school teachers, in the past few years, have changed their attitudes toward girls studying mathematics?

10. Summarize your views on society's barriers against women in mathematics. To what extent do educators at various levels build barriers or attempt to remove them? Have you perceived any significant changes in attitudes in the past few years? What role should educators play in removing barriers against women in mathematics? How can these changes be effected?

Interviews

Twelfth Grade Guidance Counselors

1. To what extent do you feel that you influence the career choices of the students in your school? Explain.

2. In your counseling sessions, do you treat boys different than girls? If so, in what way is the treatment different.

3. To what extent do you feel that you influence the students in your school to continue or discontinue their study of mathematics? Explain.

4. Has the possibility of discrimination against women influenced your counseling girls about future careers? In what way?

5. Have you ever warned girls of probable discrimination against them? Under what circumstances?

6. Have you ever given preferred treatment to girls? In what way?

7. Has the possibility of preferred treatment influenced your counseling girls about future education or careers? In what way?

8. In the Department of Mathematics in your school, is there discrimination against girls as students? against women as teachers? Was there discrimination at any time? What steps were taken to solve the problem?

9. Do you think that elementary and secondary school teachers and guidance counselors, in the past few years, have changed their attutides toward girls studying mathematics?

10. Summarize your views on society's barriers against women in mathematics. To what extent do teachers or guidance counselors, at various levels, build barriers or attempt to remove them? Have you perceived any significant changes in attitudes in the past few years? What role should education play in removing barriers against women in mathematics? How can these changes be effected?

COLLEGE SOPHOMORES SURVEY

____ Male Father's Occupation _____

____ Female Mother's Occupation _____

College mathematics courses already completed:

_____

_____

1. List any mathematics courses which you are taking or which your plan to take as an undergraduate or a graduate student.

2. List the career or careers which you are currently considering. Be as specific as you can.

3. Have your parents influenced your choice of careers? If so, explain how they have influenced you.

4. Have your teachers or college professors influenced your choice of careers? If so, explain how they have influenced you.

5. Have your high school guidance counselors or college academic advisors influenced your choice of careers? If so, explain how they have influenced you.

I am willing to participate in an interview to discuss these items in greater detail.

_____
Signature

MATHEMATICS QUESTIONNAIRE

College Sophomores

____ Freshman ____ Sophomore ____ Junior ____ Senior

List the college mathematics courses which you have completed or in which you are now enrolled.

_____

_____

_____

_____

_____

Directions: Each statement below represents a belief or a behavior exhibited by college students of mathematics. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree), SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure that none of the other responses applies to you.

		SA	A	U	D	SD
1.	I continue to read and study a new mathematical concept until I completely understand it.	O	O	O	O	O
2.	I have found very few uses for mathematics in other academic areas.	O	O	O	O	O
3.	I enjoy doing mathematics for its own sake, regardless of its potential usefulness.	O	O	O	O	O
4.	I see no value in studying the relationships among various branches of mathematics.	O	O	O	O	O
5.	I do not plan to study advanced mathematics.	O	O	O	O	O
6.	I sometimes work ahead of the class.	O	O	O	O	O
7.	I have never studied a mathematical topic outside of formal class work.	O	O	O	O	O
8.	I frequently ask questions involving generalizations, unifying concepts, or applications.	O	O	O	O	O
9.	I enjoy following the logical development of a mathematical proof.	O	O	O	O	O
10.	I do not have the patience for mathematical computation.	O	O	O	O	O
11.	I have no talent in mathematics.	O	O	O	O	O
12.	I am more interested in learning the "how" than the "why" of mathematics.	O	O	O	O	O

		SA	A	U	D	SD
13.	Mathematics problems are a challenge; solving problems provides satisfactions similar to those of winning a battle.	0	0	0	0	0
14.	I learn mathematics so that I can use it, not just to pass an exam.	0	0	0	0	0
15.	I try hard to understand mathematics.	0	0	0	0	0
16.	I have never read a mathematics book other than my textbooks.	0	0	0	0	0
17.	Working on mathematics problems is drudgery.	0	0	0	0	0
18.	I do not try to learn mathematics on my own.	0	0	0	0	0
19.	I never work on more challenging problems than those which are assigned.	0	0	0	0	0
20.	Problem solving fascinates me.	0	0	0	0	0
21.	My leisure reading includes mathematics books.	0	0	0	0	0
22.	I prefer word games and puzzles rather than mathematical puzzles.	0	0	0	0	0
23.	Watching an ice skater would arouse my curiosity about deriving a function for the two dimensional pattern of the tracks left in the ice.	0	0	0	0	0
24.	It isn't necessary for everyone to know mathematics.	0	0	0	0	0
25.	I work on mathematics primarily because I enjoy it, not because I am being graded in the course.	0	0	0	0	0
26.	I expect to use mathematics in my chosen career.	0	0	0	0	0

MATHEMATICS OPINIONNAIRE

College Sophomores

Directions: Each statement below represents a belief or a behavior of a particular college student of mathematics. You are asked to express the extent to which you personally agree or disagree that the statement describes you. Responses are to be made on a 5-point scale: SA (Strongly Agree), A (Agree), U (Undecided), D (Disagree) and SD (Strongly Disagree). Fill in the circle at the right indicating the extent of your agreement that the statement describes you. Use the Undecided response only if you are sure none of the other responses applies to you.

		SA	A	U	D	SD
1.	I often feel that mathematics assignments are overwhelmingly long and difficult.	O	O	O	O	O
2.	If I am confronted with a new mathematical situation, I can cope with it because I have a good background in mathematics.	O	O	O	O	O
3.	I work on mathematics assignments first because I know that I can finish them rapidly and easily.	O	O	O	O	O
4.	I have greater talent in academic areas other than mathematics.	O	O	O	O	O
5.	I am not capable of learning advanced mathematics.	O	O	O	O	O
6.	I get flustered if I am confronted with a problem different from the problems worked in class.	O	O	O	O	O
7.	I can draw upon a wide variety of mathematical techniques to solve a particular problem.	O	O	O	O	O
8.	I feel that I have a good working knowledge of the mathematics courses I have taken so far.	O	O	O	O	O
9.	Mathematics is difficult.	O	O	O	O	O
10.	I feel afraid when I begin a mathematics course.	O	O	O	O	O
11.	After I have written the answer to a quiz problem, I do not find it necessary to reread the solution or check for possible errors.	O	O	O	O	O
12.	I believe that if I work long enough on a mathematics problem, I will be able to solve it.	O	O	O	O	O

		SA	A	U	D	SD
13.	I have forgotten many of the mathematical concepts which I have learned.	O	O	O	O	O
14.	I look forward to attending classes in mathematics.	O	O	O	O	O
15.	I begin to work on a mathematics problem by telling myself that I can solve it.	O	O	O	O	O
16.	I learn mathematics by understanding the underlying logical principles, not by memorizing rules.	O	O	O	O	O
17.	I enjoy solving mathematics problems.	O	O	O	O	O
18.	When I begin a mathematics assignment, I feel that I shall be able to work the problems.	O	O	O	O	O
19.	I would hesitate tutoring anyone in mathematics.	O	O	O	O	O
20.	I make a considerable number of errors in working mathematics problems.	O	O	O	O	O
21.	It is difficult to understand the language and symbolism of mathematics.	O	O	O	O	O
22.	I cannot get good grades in mathematics without doing a great deal of work.	O	O	O	O	O
23.	I answer mathematics questions which are asked by other students.	O	O	O	O	O
24.	I often look at a set of mathematics problems and feel that I cannot solve them.	O	O	O	O	O

Interviews

College Sophomores

1. What careers are you currently considering? Why?

2. Who has encouraged you to choose this career? Who has discouraged you? In what way?

3. Do teachers or college professors, with whom you have come in contact, treat male students different from female students in mathematics classes? In what way has the treatment been different?

4. Are you planning further study of mathematics? If so, are professors more or less supportive than your peers of this decision? More or less supportive than your family?

5. Did counselors in elementary or high school or college advisers play any part in your educational or career decisions?

6. At any stage in your education, have you felt any discrimination against women in mathematics? Explain. Were you, on the other hand, ever given preferred treatment as a woman? Explain.

7. Has the possibility of discrimination against women influenced your thinking about a future career? In what way?

8. Have you ever been warned of probable discrimination against you as a woman? By whom? Under what circumstances?

9. In the U.C. Department of Mathematics, do you think that there is any discrimination against women students?

10. Do you think that elementary, secondary, or college educators in the past few years, have changed their attitudes toward girls studying mathematics?

11. Summarize your views on society's barriers against women in mathematics. To what extent do educators at various levels build barriers or attempt to remove them? Have you perceived any significant changes in attitudes in the past few years? What role should educators play in removing barriers against women in mathematics? How can these changes be effected?

Interviews

College Instructors

1. To what extent do you feel that you influence the career choices of your students? Explain.

2. In your classes, do you treat men different from women? If so, in what way is the treatment different?

3. To what extent do you feel that you influence your students to continue or discontinue their study of mathematics? Explain.

4. Has the possibility of discrimination against women influenced your counseling women about future careers? In what way?

5. Have you ever warned women of possible discrimination against them? Under what circumstances?

6. Have you ever given preferred treatment to women students? In what way?

7. Has the possibility of preferred treatment influenced your counseling women about future education or careers? In what way?

8. In the U.C. Department of Mathematics, is there discrimination against women as students? against women as faculty members? Was there discrimination at any time? What steps were taken to solve the problem?

9. Do you think that elementary, secondary, or college teachers, in the past few years, have changed their attitudes toward girls studying mathematics?

10. Summarize your views on society's barriers against women in mathematics. To what extent do educators at various levels build barriers or attempt to remove them? Have you perceived any significant changes in attitudes in the past few years? What role should educators play in removing barriers against women in mathematics? How can these changes be effected?

Interviews

Mathematicians

1. When did you decide to pursue a career in mathematics?

2. Who encouraged you? Who discouraged you? In what way?

3. Did teachers or college professors, with whom you came in contact, treat male students different from female students in mathematics classes? In what way was the treatment different?

4. Were teachers more or less supportive than your peers of your decision to study mathematics? More or less supportive than your family?

5. Did counselors in elementary or high school or college advisers play any part in your educational or career decisions?

6. At any stage in your education, did you feel discrimination against women in mathematics? Explain. Were you, on the other hand, ever given preferred treatment as a woman? Explain.

7. As a professor of mathematics, have you experienced discrimination against women? Describe. Have you experienced preferred treatment as a woman? Describe.

8. Have you ever held any non-academic position as a mathematician? Did you ever seek such a position? Did you feel any discrimination against women?

9. When you were a student, were you ever warned of probable discrimination against you as a woman? By whom? Under what circumstances?

10. In your Department of Mathematics, is there discrimination against women students? Was there discrimination at any time? What steps were taken to solve the problem?

11. Do you think that elementary and secondary school teachers in the past few years, have changed their attitudes toward girls studying mathematics?

12. Summarize your views on society's barriers against women in mathematics. To what extent do educators at various levels build barriers or attempt to remove them? Have you perceived any significant changes in attitudes in the past few years? What role should educators play in removing barriers against women in mathematics? How can these changes be effected?